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E1D DF144 DLELA2 D104 D117 D2120 D2134

(56) Documents cited
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GB 0920202 A JP 63251567 A JP 60252775 A
JP 53077267 A

(58) Field of search
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(54) Apertured fibre-reinforced plastics sheet

(57) A fiber-reinforced plastics sheet to be embedded in a mortar layer 8 formed on a surface of a concrete member, is a non-woven fabric 11 formed by entangling short reinforcing fibers in random three-dimensional directions and bonding them each other at their contact points with a curing resin, the sheet having a plurality of holes 6. The fiber-reinforced plastics sheet is used in combination with building materials and becomes firmly integral with mortar 8 so as to greatly alleviate strains due to differential movements which is caused by a temperature change and an earthquake, and to prevent a surface-finishing material, mortar 70 or tiles 10, from falling from the outer surface of a concrete wall 7 or other building structure. The holes allow knobs of mortar 50 to protrude through the sheet.

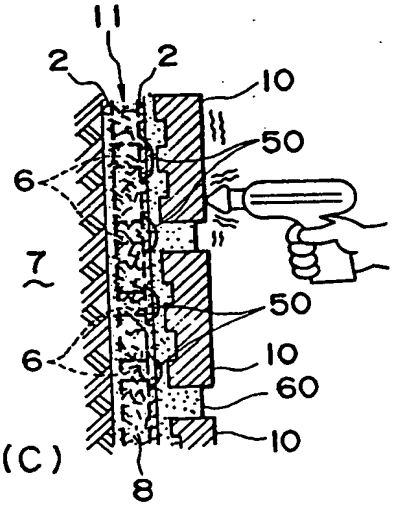

FIG. 4 (C)

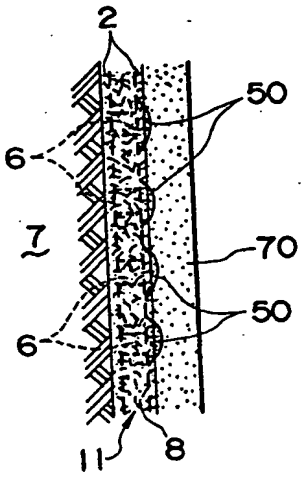

FIG. 5

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FIG. 1(A)

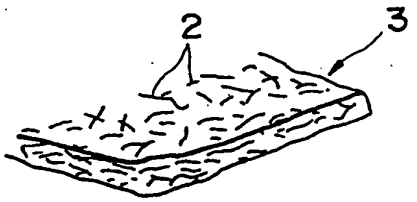


FIG. 1(B)

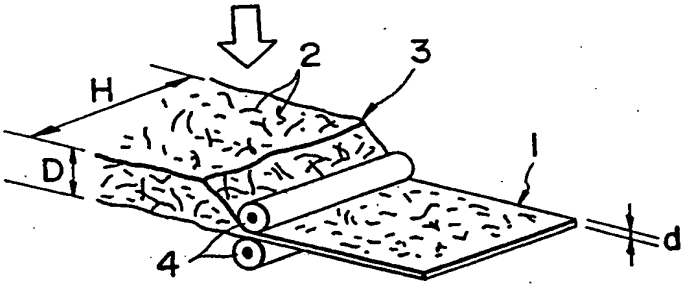


FIG. 2

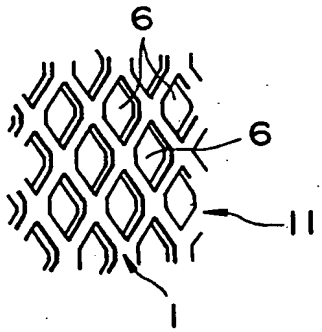


FIG. 3

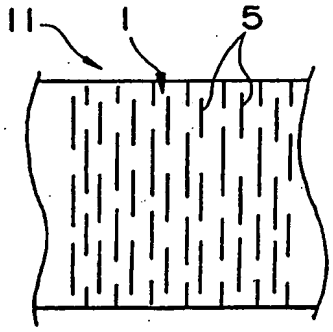


FIG. 4 (A)

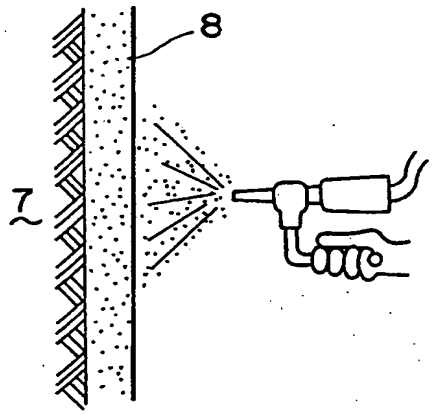


FIG. 4 (B)

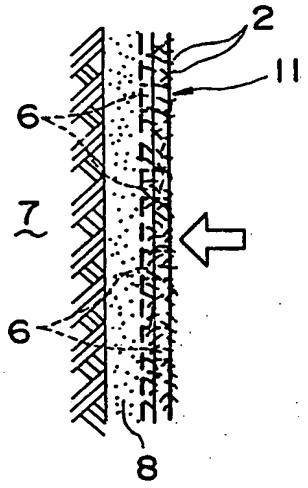


FIG. 4 (C)

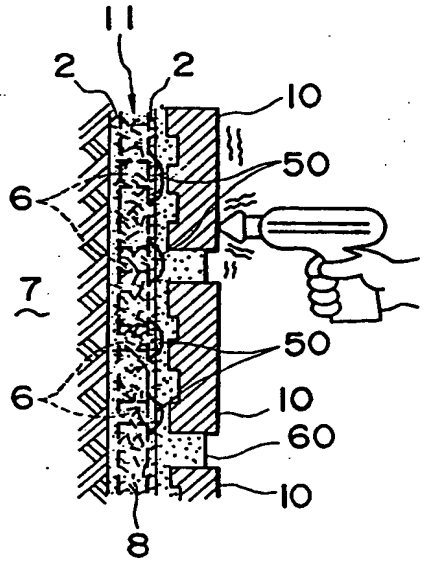


FIG. 5

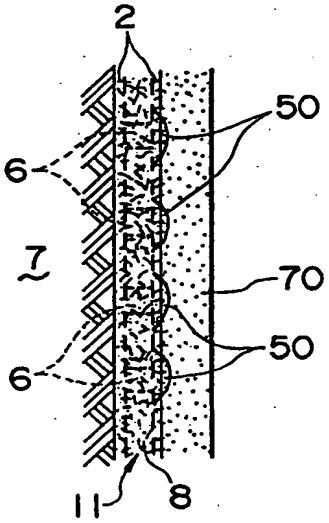


FIG. 6 (A)

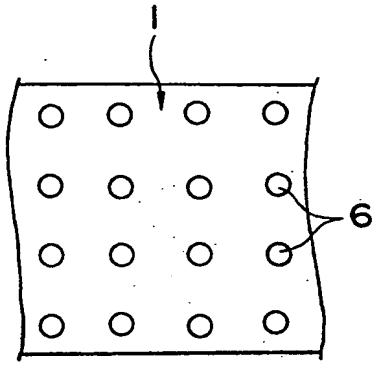


FIG. 6 (B)

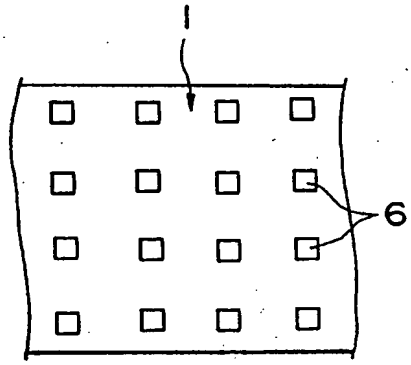
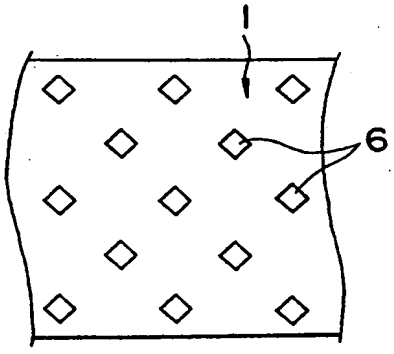


FIG. 6 (C)



FIBER-REINFORCED PLASTIC SHEET AND APPLICATION METHOD OF SURFACE-FINISHING FOR CONCRETE MEMBER

BACKGROUND OF THE INVENTION

1. Field of the Invention:

The present invention relates to a fiber-reinforced plastic sheet and an application method of surface-finishing for concrete member, and more particularly, it is concerned with them suitable for use in combination with concrete (mortar) and other building materials for preventing a surface-finishing member such as a tile from separating and falling off from outer surfaces of concrete walls of a building structure because of the spalling of the surface-finishing member from the concrete walls.

2. Description of the Prior Art:

Fiber-reinforced plastic sheet (abbreviated as FRP sheet hereinafter) is usually produced by laminating several sheets, each sheet consisting of reinforcing fibers and a infiltrating and curing resin such as epoxy resin. In each sheet, the reinforcing fibers are continuous fibers of high strength and high modulus, such as carbon fiber and aramid fiber, and they are arranged in one direction. On curing, the infiltrating resin forms a sheet in which the continuous fibers are integrated. Because of this structure, FRP sheets have the directional property of mechanical strength which varies depending on the direction in which the fibers are oriented. In other words, FRP sheets are very strong in the longitudinal direction in which the fibers are oriented, whereas they are very weak in the transverse direction.

In the case where it is necessary that FRP sheets have high strength in both the longitudinal direction and the lateral direction, the above-mentioned unidirectional FRP sheets are laminated in such a manner that the direction of fiber orientation in one sheet is perpendicular to that in its adjacent layer. For example, Japanese Patent Publication No. 54207/1981 discloses a method for producing an FRP sheet of desired thickness from prepreg sheets formed by infiltrating unidirectionally arranged fibers with a curing resin. According to this method, prepreg sheets are laminated, with fibers in one sheet crossing at right angles with fibers in its adjacent sheets, so that the thermal shrinkage and its concomitant warpage resulting from the fiber orientation cancel out. Therefore, the resulting FRP sheet has uniform strength in all directions to meet requirements.

In the meantime, the recent technical trend in the building industry is toward reduction in the weight of building members, improvement in the durability of building members, and labor saving. Attempts are being made to achieve this objective by combining FRP sheets with concrete and other building materials. FRP sheets are considered promising because of their high tensile strength, light weight, and good corrosion resistance.

Unfortunately, FRP sheets have a smooth surface which makes them poor in adhesion to concrete and other building materials. In other words, they do not ensure the integrality of the composite material.

Another disadvantage of conventional FRP sheets is the necessity of laminating several layers in different directions.

This leads to a complex production process and a high production cost.

A possible application of high-strength FRP sheets to building work is the replacement of non-woven fabrics (or similar reinforcing materials) which are embedded in mortar as the surface finish of the building wall or as the binder for tiles. However, the FRP sheets embedded in mortar would cause the peeling or spalling of mortar or tiles when differential movements occur, because conventional FRP sheets do not integrally adhere to mortar, as mentioned above.

SUMMARY OF THE INVENTION

The present invention was completed in view of the above-foregoing. It is an object of the present invention to provide an inexpensive fiber-reinforced plastic sheet which is suitable for use as a reinforcing material to be embedded in mortar when the concrete building member is surface-finished with mortar or mortar-bonded tiles, and to provide an application method of surface-finishing for concrete member applied such fiber-reinforced plastic sheet. The FRP sheet of the present invention adheres well to concrete (mortar) and other building materials to form an integral composite material, so it prevents surface-finishing materials and so on from falling off from the surface of the concrete member.

The first aspect of the present invention is embodied in a fiber-reinforced plastic sheet formed like a non-woven fabric by entangling short reinforcing fibers in the three-dimensional directions and fixing them each other at their contact points with a curing resin.

The second aspect of the present invention is embodied in a fiber-reinforced plastic sheet to be embedded in a mortar layer formed on a surface of a concrete member, being formed like a non-woven fabric by entangling short reinforcing fibers in the three-dimensional directions and fixing them each other at their contact points with a curing resin, and the sheet having a plurality of holes.

The third aspect of the present invention is embodied in an application method of surface-finishing for concrete member comprising: a first step to press a fiber-reinforced plastic sheet against an unhardened mortar layer formed on a surface of the concrete member so as to attach the sheet thereto, the fiber-reinforced plastic sheet being formed like a non-woven fabric by entangling short reinforcing fibers in the three-dimensional directions and fixing them each other at their contact points with a curing resin, and having a plurality of holes through which the mortar is pushed out by the pressure; a second step to form protruding portions of the unhardened mortar pushed out of the holes; and a third step to apply a surface-finishing material over the protruding portions.

The fourth aspect of the present invention is embodied in an application method of surface-finishing for concrete member comprising: a first step to press a fiber-reinforced plastic sheet against an unhardened mortar layer formed on a surface of the concrete member so as to attach the sheet thereto, the fiber-reinforced plastic sheet being formed like a non-woven fabric by entangling short reinforcing fibers in the three-dimensional directions and fixing them each other at their

contact points with a curing resin, and having a plurality of holes through which the mortar is pushed out by the pressure; a second step to form protruding portions of the unhardened mortar pushed out of the holes; and a third step to attach surface-finishing members to the concrete member side through a mortar for adhesion which covers and adheres to the protruding portions.

The fiber-reinforced plastic sheet of the present invention has a fluffy surface due to short fibers extending from the sheet surface. When the fiber-reinforced plastic sheet is used in combination with a building matertal, the fluffy surface functions as mechanical anchorage for improved adhesion.

In the case where the sheet of the present invention has a plurality of holes therein, an unhardened mortar applied on a concrete member is pushed out of the holes to the surface of the sheet easily by pressing the sheet against the mortar, so that the protruding portions of the unhardened mortar are formed on the surface of the sheet. These protruding portions also function as mechanical anchorage for a surface-finishing material such as a finishing mortar or a surface-finishing members such as a tile attached through a mortar binder. Then, these protruding portions improve adhesion. Of course, the anchorage of the fluff is also ensured.

It is understood that the sheet functions as a powerful reinforcing material for a bed on the surface of the concrete member. It greatly alleviates strains due to differential movements which is caused by a temperature change and an earthquake and the like. As the result, the sheet prevents the

surface-finishing material and member from separating and falling off from outer surface of concrete member of the building structure.

Furthermore, the sheet has good fire resistance, and durability because it does not corrode.

Moreover, the sheet obviates the need of laminating unidirectionally oriented fiber layers. Therefore, it can be produced easily at a low production cost.

The application method of surface-finishing for concrete member of the present invention uses the sheet of the present invention. The sheet being pressed against the unhardened mortar layer formed on the surface of the concrete member, the protruding portions of the unhardened mortar is formed on the surface of the sheet. When the mortar hardens, the protruding portions function as mechanical anchorage. Then, the surface-finishing material is applied over the hardened protruding portions, or the surface-finishing members are attached to the hardened protruding portion of the concrete member side through a mortar for adhesion which covers and adheres to the protruding portions. The protruding portions of the mortar together with fluff of the sheet prevent the surface-finishing material or members from fall off from the surface of the concrete member.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic representation showing the steps of producing the fiber-reinforced plastic sheet of the present invention.

Fig. 2 is a perspective view showing an embodiment of the

fiber-reinforced plastic sheet of the present invention.

Fig. 3 is a plan view showing an intermediate product of the fiber-reinforced plastic sheet shown in Fig. 2.

Figs. 4(A) to 4(C) are sectional views illustrating the steps of tile-finishing a concrete building member.

Fig. 5 is a sectional view showing another application to apply a surface-finishing mortar over protruding portions of a mortar.

Fig.s 6(A) to 6(C) are schematic plan views showing the modified embodiments to the fiber-reinforced plastic sheet pertaining to the second aspect of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The embodiments of the invention will be described with reference to the accompanying drawings. Fig. 1 is a schematic illustration showing the process for producing the FRP sheet of the invention. The FRP sheet 1 is produced by processing the felt-like fibrous body 3 which is a long web having a width H and a thickness D. The felt-like fibrous body 3 is formed by entangling short reinforcing fibers 2 randomly in the three-dimensional directions. The short fibers 2 are carbon fibers or aramid fibers which have a high strength and high modulus and are superior in corrosion resistance and fire resistance. The felt-like fibrous body 3 is previously infiltrated with a curing epoxy resin by dipping and the like. In other words, it comes in the form of prepreg mat. The felt-like fibrous body 3 has large interstices among short fibers 2, so that it is spongy and compressible to desired thickness. The epoxy resin infiltrated into the felt-like fibrous body 3 is

a thermosetting resin, and it covers the surface of each of the short fibers 2 so that it fastens the short fibers to one another upon curing by the application of heat.

The felt-like fibrous body 3 is continuously fed to the press roller 4 which performs cold pressing. Upon pressing, the short reinforcing fibers 2 are bonded to one another by the epoxy resin. Thus there is obtained the FRP sheet 1 which resembles a non-woven fabric. The obtained FRP sheet 1 has a thickness d which is approximately equal to the clearance of the press roller 4 and has a width which is equal to the width H of the felt-like fibrous body 3.

The FRP sheet 1 in the form of continuous web has individual short reinforcing fibers 2 entangled in such a manner that they have interstices in proportion to the compression ratio in the thickness direction and also has individual short fibers 2 bonded to one another with the epoxy resin in the compressed state. The web of the FRP sheet 1 is cut in lengths according to the desired width and length. The obtained FRP sheet 1 has sufficient strength not only in the lengthwise and widthwise directions but also in the thickness direction and is not subject to cleavage, because it is composed of short reinforcing fibers 2 which are entangled in the three-dimensional directions, compressed in the thickness direction, and bonded together with the resin in the compressed state.

In addition, the above-mentioned FRP sheet 1 has a fluffy surface due to short reinforcing fibers 2 extending from its surface, because it is made from the felt-like fibrous body 3 in which a large number of short fibers 2 are entangled in the

three-dimensional directions. This fluffy surface is advantageous when the FRP sheet 1 is used in combination with building materials (such as boards) or embedded in building materials (such as concrete and gypsum board), because it provides mechanical anchorage for improved adhesion to the building members.

The compression of the felt-like fibrous body 3 is accomplished according to a predetermined compression ratio D/d which depends on the desired thickness of the FRP sheet 1 and the desired strength in the thickness direction.

Fig. 2 shows an embodiment of the FRP sheet of the present invention. Fig. 3 shows an intermediate product of the FRP sheet shown in Fig. 2. This FRP sheet 11 is obtained in the following manner by fabricating the above-mentioned FRP sheet 1. In the compressing step shown in Fig. 1(B), the felt-like fibrous body 3 is perforated zigzag as shown in Fig. 3. (Perforations are indicated by a reference numeral 5.) In the subsequent step, the FRP sheet 11 is stretched in its widthwise direction. The resulting FRP sheet 11 has a large number of holes 6 which form a reticulate structure. Therefore, the FRP sheet 11 is suitable for use as a reinforcing material for a bed which is embedded in mortar for the surface finishing of the concrete building members.

Figs. 4(A) to 4(C) are sectional views showing how the FRP sheet 11 is used to finish the surface of the concrete building wall with tiles. In the first step as shown in Fig. 4(A), the surface of the concrete building wall 7 is provided with a mortar layer 8. In the second step as shown in Fig. 4(B), the FRP sheet

11 is embedded in the unhardened mortar layer 8 by pressing it against the layer 8 before the mortar sets. Thereby, the FRP sheet 11 is attached to the concrete building wall side. In the third step, protruding portions 50 of the unhardened mortar are formed on the surface of the FRP sheet 11 by the mortar being pushed out of the holes 6 because of the pressing operation. Then, the protruding portions 50 are fully dried until possible shrinkage of the mortal by drying is completely finished. In the fourth step as shown in Fig. 4(C), tiles 10 are attached to the concrete building wall 7 through another mortar 60 for adhesion which covers and adheres to the protruding portions 50.

Preferably, after forming the protruding portions 50 of the unhardened mortar, an intermediate mortar (not shown) is applied over the protruding portions 50 so as to cover them. Subsequently, the intermediate mortar and the mortar layer 8 including the protruding portions 50 are dried until the shrinkage being finished. After that, the tiles 10 which applied the mortar for adhesion to the rear surface thereof are attached to the concrete building wall side.

Fig. 5 shows another application to apply a surface-finishing mortar 70 over the protruding portions 50 of the mortar. In the first step, the surface of the concrete building wall 7 is provided with the mortar layer 8. In the second step, the FRP sheet 11 is embedded in the unhardened mortar layer 8 by pressing it against the layer 8 before the mortar sets. Thereby, the FRP sheet 11 is attached to the concrete building wall side. In the third step, protruding portions 50 of the unhardened mortar are formed on the surface

of the FRP sheet 11 by the pressing operation. Then, the protruding portions 50 are fully dried until possible shrinkage of the mortal by drying is completely finished. In the fourth step, the finishing mortar 70 are applied over the protruding portions 50 to cover and adhere to them.

Preferably, after forming the protruding portions 50 of the unhardened mortar, an intermediate mortar (not shown) is applied over the protruding portions 50 so as to cover them. Subsequently, these intermediate mortar and the mortar layer 8 including the protruding portions 50 are dried until the shrinkage being finished. After that, the finishing mortar 70 are applied to the concrete building wall side.

This application method and the FRP sheets 1 and 11 embedded in the mortar layer 8 between the concrete building member such as a wall 7 and the finishing mortar 70 or the finishing member such as a tile 10 produce the following effect. Since each of the FRP sheets 1 and 11 has a fluffy surface due to short reinforcing fibers 2 extending from the surface, as in the case of the above-mentioned FRP sheets 1 and 11, it firmly adheres to the concrete building wall 7, the mortar layer 8, and the tiles 10 owing to the mechanical anchorage of the FRP sheet.

In the case where each of the FRP sheets 1 and 11 has a plurality of holes 6 therein, an unhardened mortar applied on a concrete building wall 7 is pushed out of the holes 6 to the surface of the FRP sheets 1 and 11 easily by pressing the FRP sheets 1 and 11 against the mortar, so that the protruding portions 50 of the unhardened mortar are formed on the surface of the FRP sheets 1 and 11. These protruding portions 50 also

function as mechanical anchorage for a surface-finishing material such as a finishing mortar 70 or a surface-finishing members such as a tile 10. Then, these protruding portions 50 improve adhesion. Of course, the anchorage of the fluff is also ensured. Moreover, the holes 6 holding the mortar becomes firmly integral with the mortar layer 8 in which it is embedded.

It is understood from the above-foregoing that the FRP sheets 1 and 11 function as a powerful reinforcing material for the bed on the surface of the concrete member. It greatly alleviates strains due to differential movements. As the result, the present invention prevents the surface-finishing material and member from separating and falling off from outer surface of concrete member of the building structure.

Furthermore, the FRP sheets 1 and 11 have good fire resistance, and durability because they do not corrode.

Moreover, the FRP sheets 1 and 11 have economical advantages over the conventional FRP sheets, because they do not need the steps of laminating unidirectionally oriented sheets in different directions and hence they can be produces easily at a low production cost. Also, they are made with short reinforcing fibers 2 which are less expensive than continuous fibers used for the conventional FRP sheets.

In the meantime, the holes 6 which are formed in the FRP sheet 11 are not restricted to those shown in Fig. 2, but they may take other shapes as shown in Fig.s 6(A) to 6(C), which are formed by punching. Needless to say, these holes produce the same effect as mentioned above.

WHAT IS CLAIMED IS:

1. A fiber-reinforced plastic sheet formed like a non-woven fabric by entangling short reinforcing fibers in the three-dimensional directions and fixing them each other at their contact points with a curing resin.

2. A fiber-reinforced plastic sheet to be embedded in a mortar layer formed on a surface of a concrete member, being formed like a non-woven fabric by entangling short reinforcing fibers in the three-dimensional directions and fixing them each other at their contact points with a curing resin, and said sheet having a plurality of holes.

3. An application method of surface-finishing for concrete member comprising:

a first step to press a fiber-reinforced plastic sheet against an unhardened mortar layer formed on a surface of the concrete member so as to attach said sheet thereto, said fiber-reinforced plastic sheet being formed like a non-woven fabric by entangling short reinforcing fibers in the three-dimensional directions and fixing them each other at their contact points with a curing resin, and having a plurality of holes through which said mortar is pushed out by the pressure;

a second step to form protruding portions of said unhardened mortar pushed out of said holes; and

a third step to apply a surface-finishing material over said protruding portions.

4. An application method of surface-finishing for concrete member comprising:

a first step to press a fiber-reinforced plastic sheet

against an unhardened mortar layer formed on a surface of the concrete member so as to attach said sheet thereto, said fiber-reinforced plastic sheet being formed like a non-woven fabric by entangling short reinforcing fibers in the three-dimensional directions and fixing them each other at their contact points with a curing resin, and having a plurality of holes through which said mortar is pushed out by the pressure;

a second step to form protruding portions of said unhardened mortar pushed out of said holes; and

a third step to attach surface-finishing members to said concrete member side through a mortar for adhesion which covers and adheres to said protruding portions.

5. A fibre-reinforced plastic sheet substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

6. A method of surface-finishing a concrete member, substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

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